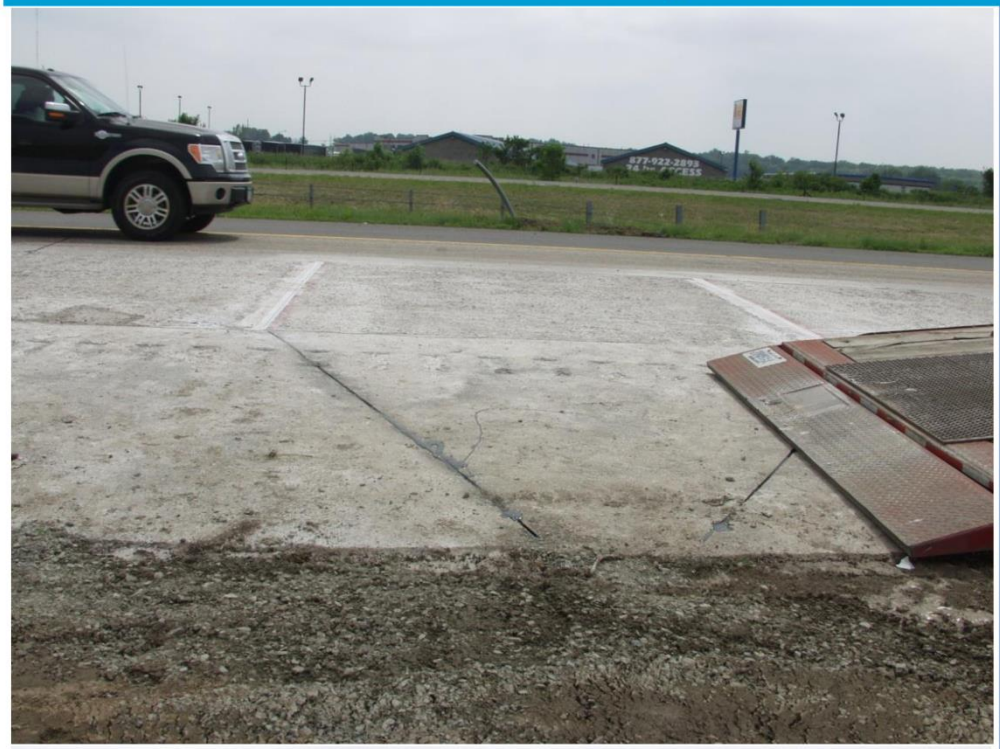
SEPTEMBER 2019



WIM #37
I-94, MP 200.1
OTSEGO, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #37 is located on I-94 near Otsego in Wright county. The WIM is located only on the westbound (WB) side of I-94, meaning that all data mentioned in this report pertains to WB traffic only (Lanes 1 and 2).

System Operation

WIM #37 was operational for the entire month of September 2019. Volume was computed using all monthly data.

System Calibration

WIM #37 was most recently calibrated on 2017-03-23. Table 1 summarizes the front axle weights of class 9s by lane [1]. Figure 1 shows the distribution of gross vehicle weights (GVW) in the Class 9s at this site for the last 12 months [2]. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 1008591 | Passenger Vehicles: 871021 | Heavy Commercial Vehicles: 137570

Monthly Average Daily Traffic (MADT): 33620 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 4586

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. WB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Mondays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), WB PVs generally reached peak volume levels between 03 PM and 05 PM.

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling WB typically reached peak volume levels between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

Overweight HCVs

Volume trends. Of a total of 137570 HCVs, 12358 of them were overweight [3]. These overweight HCVs contributed to 1.3% of total monthly volume, and 9.2% of total monthly HCV volume. WB overweight vehicles typically reached highest numbers on Fridays, with lowest volumes reported on Sundays See Figure 3 .

The top two overweight violators by class were the class 9 and class 14 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours (see Figure 7 & 8).
Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in September.
WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report [4].
Using normal load limits ,2659 WB vehicles exceeded 88,000 pounds (2039 vehicles were Class 9's; 311 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from September 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9's and 10's in September 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling WB Data also suggests that there were more NA Class 10's than NA traveling in the WB direction.

Freight Totals. A total of 1169417 tons of freight was recorded to have crossed the WIM. See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 86817 is approximately 1.2 miles east of WIM #37 and Bridge No. 86813 is approximately 4.7 miles west of WIM #37. WIM #37 recorded a total of 1008591 vehicles with a combined GVW of 10373876 kips (1 kip = 1,000 pounds = 0.5 tons) in September 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 341861 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 70% of all ESALs were generated by the Class 14's (Class 14's were also responsible for generating % of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at:
http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at:
http://www.dot.state.mn.us/traffic/data/data-products.html#weight

- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of +/-9% of baseline calibration values

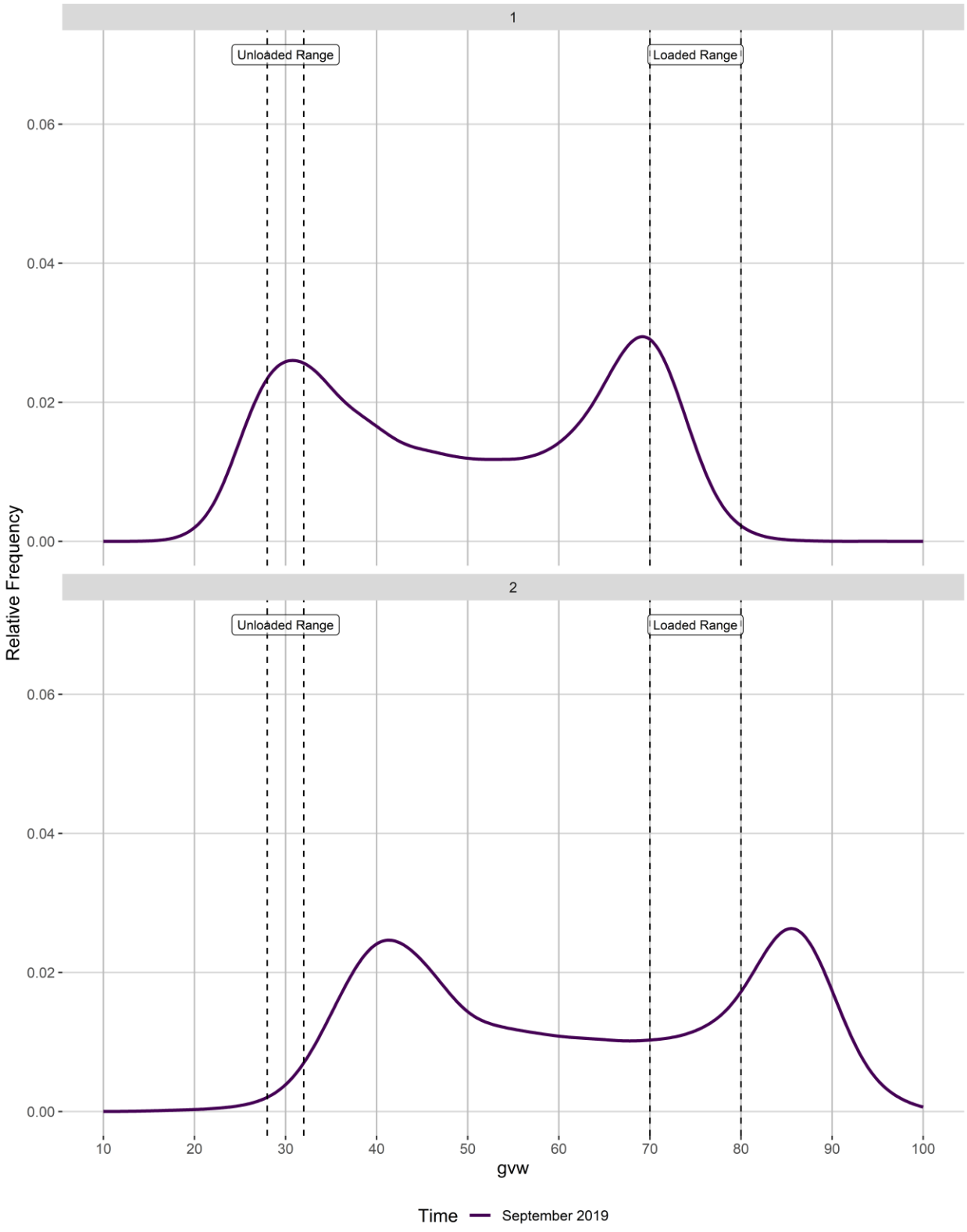
- [2] Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from

several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.

- [3] An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp

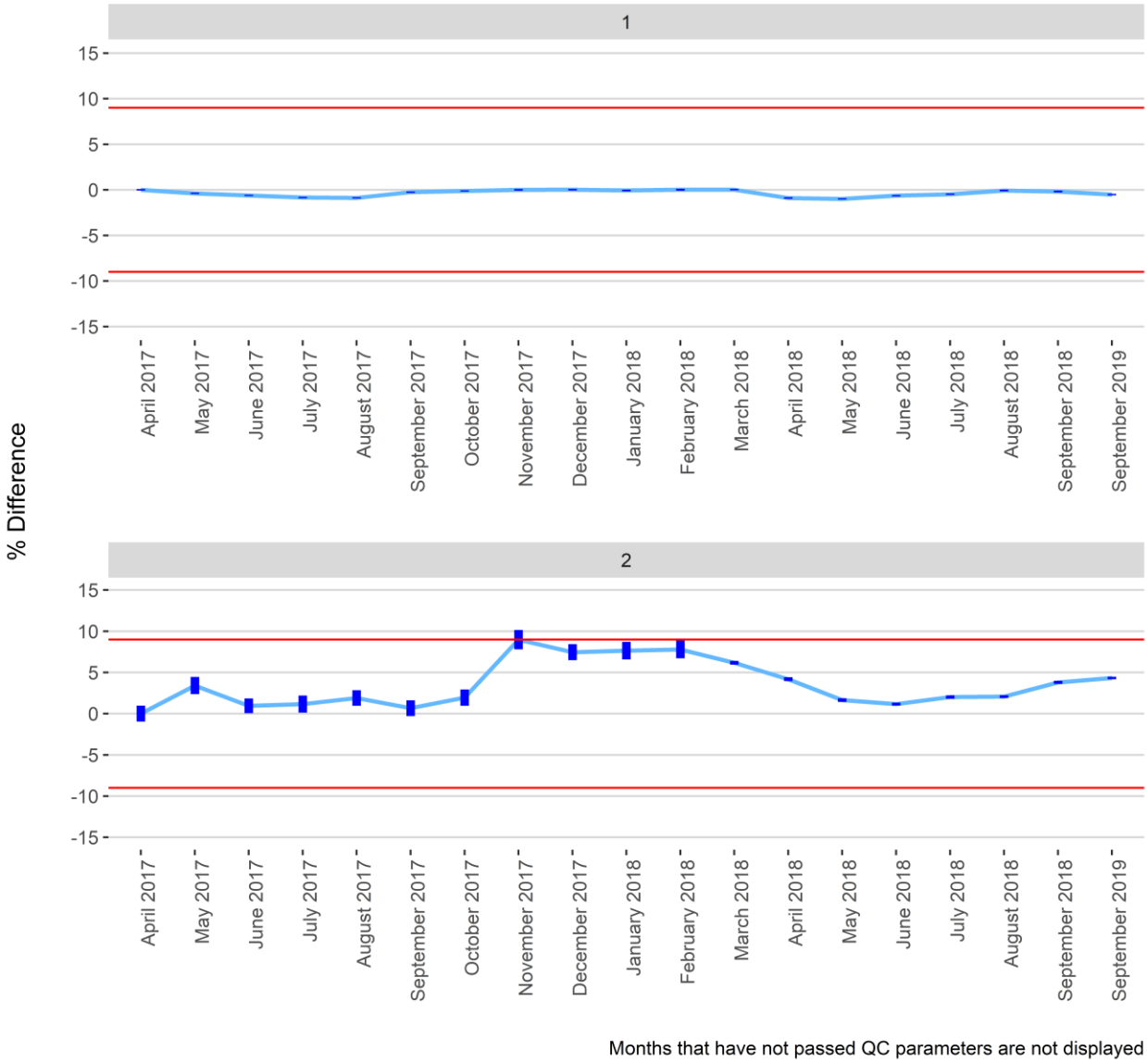
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume
vs. Day of the Week

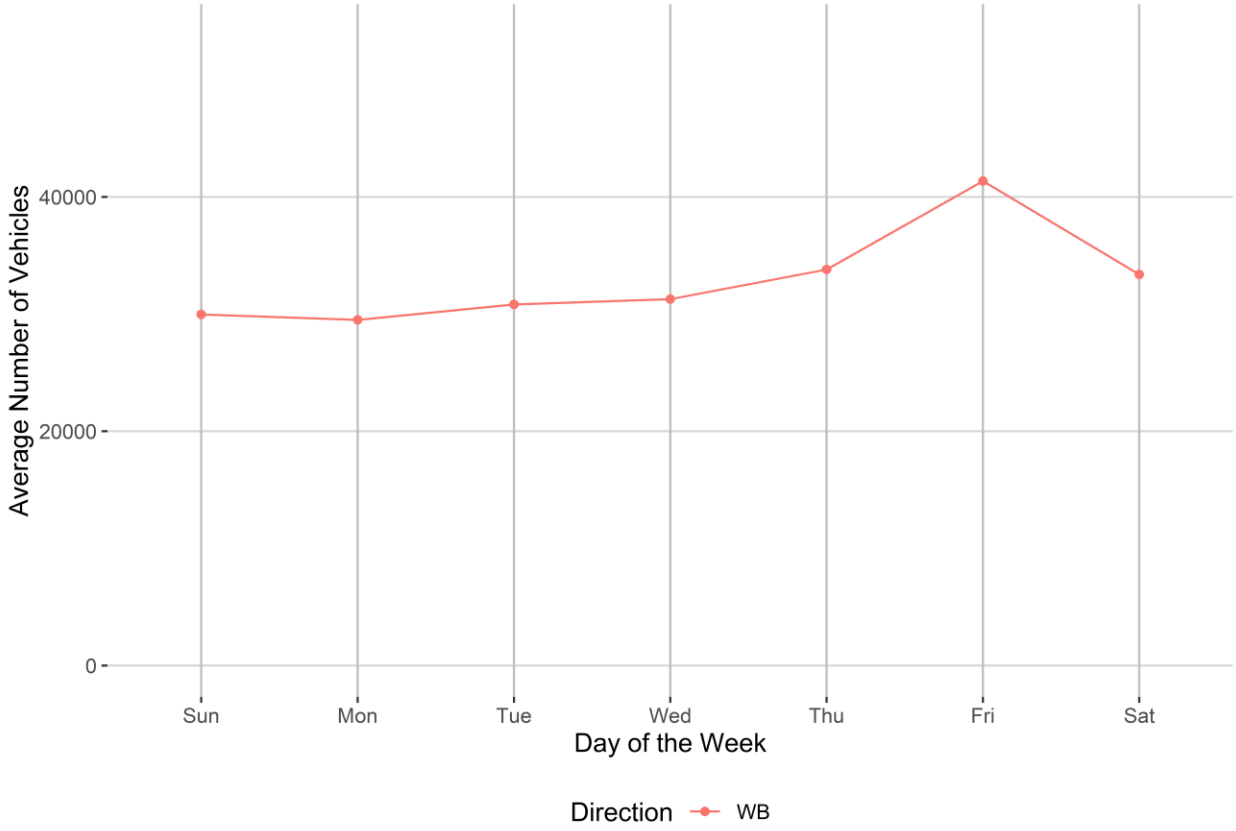


Figure 3 - Average Overweight Vehicle Volume
vs. Day of the Week

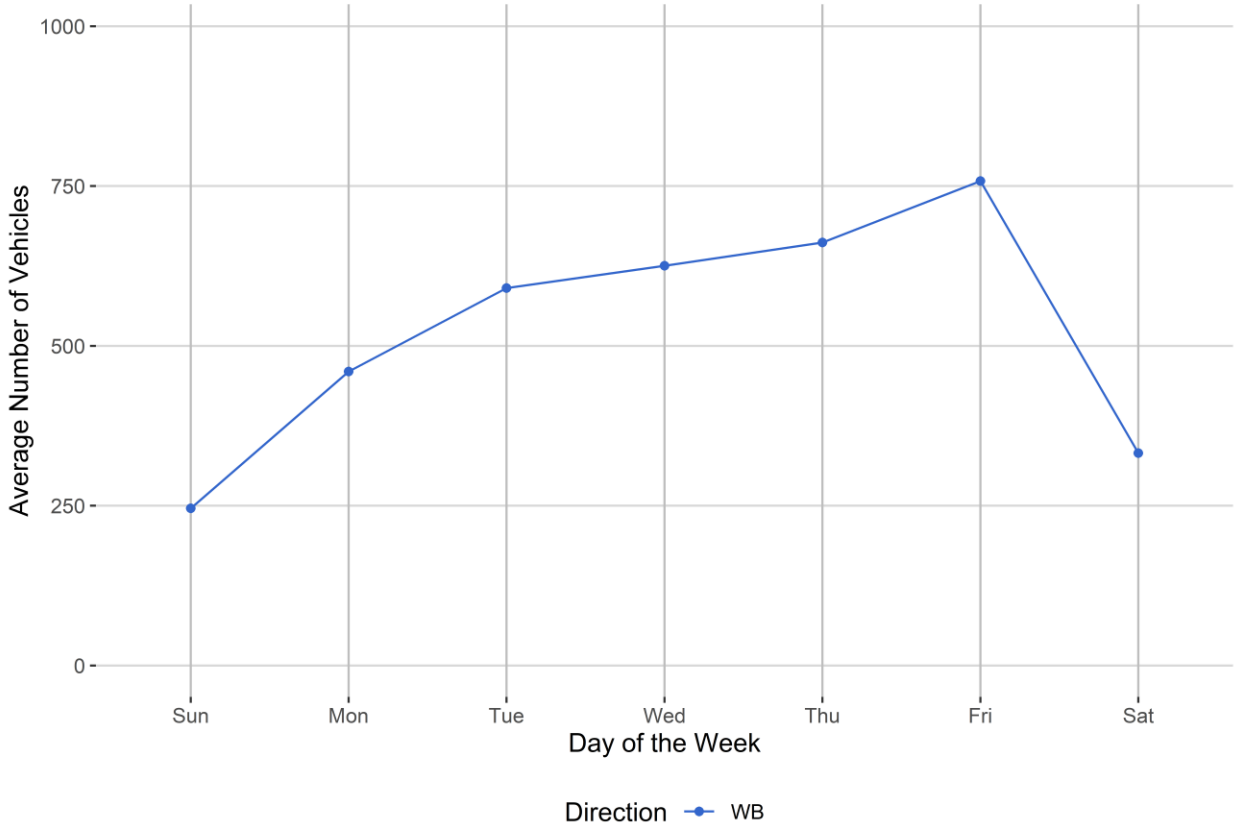


Figure 4 - Passenger Vehicles
vs. Hour of the Day

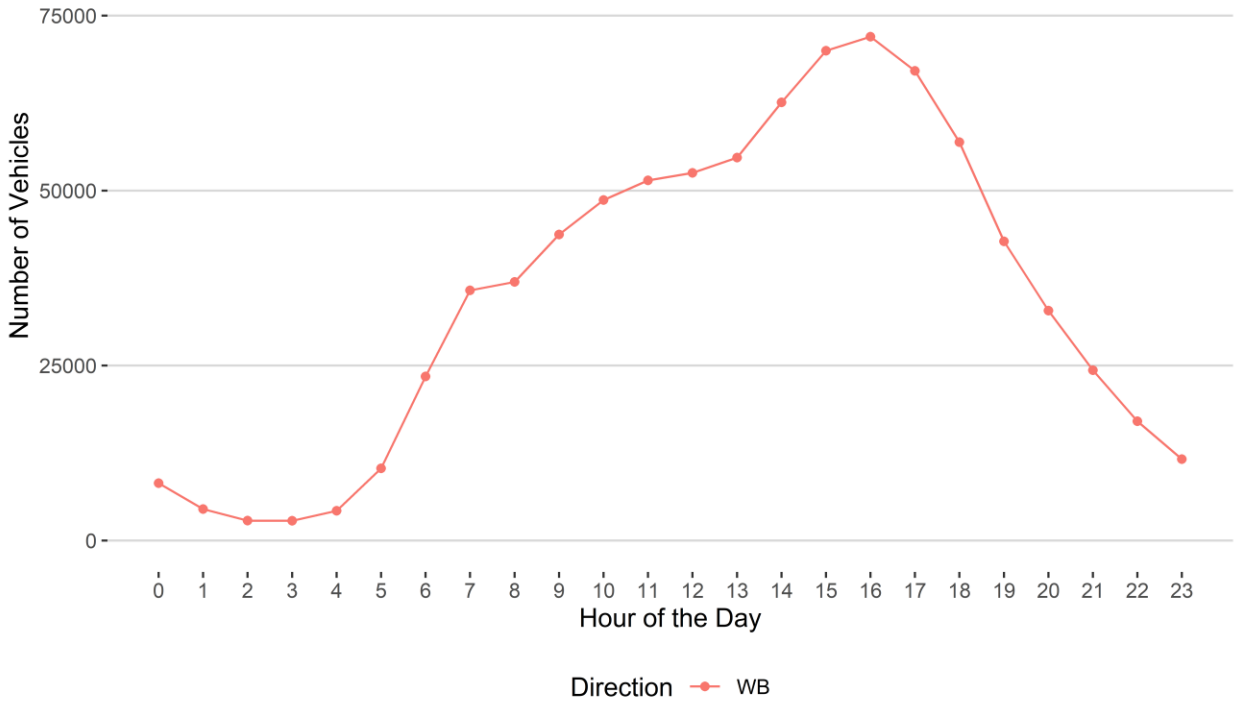


Figure 5 - Heavy Commercial Vehicles
vs. Hour of the Day

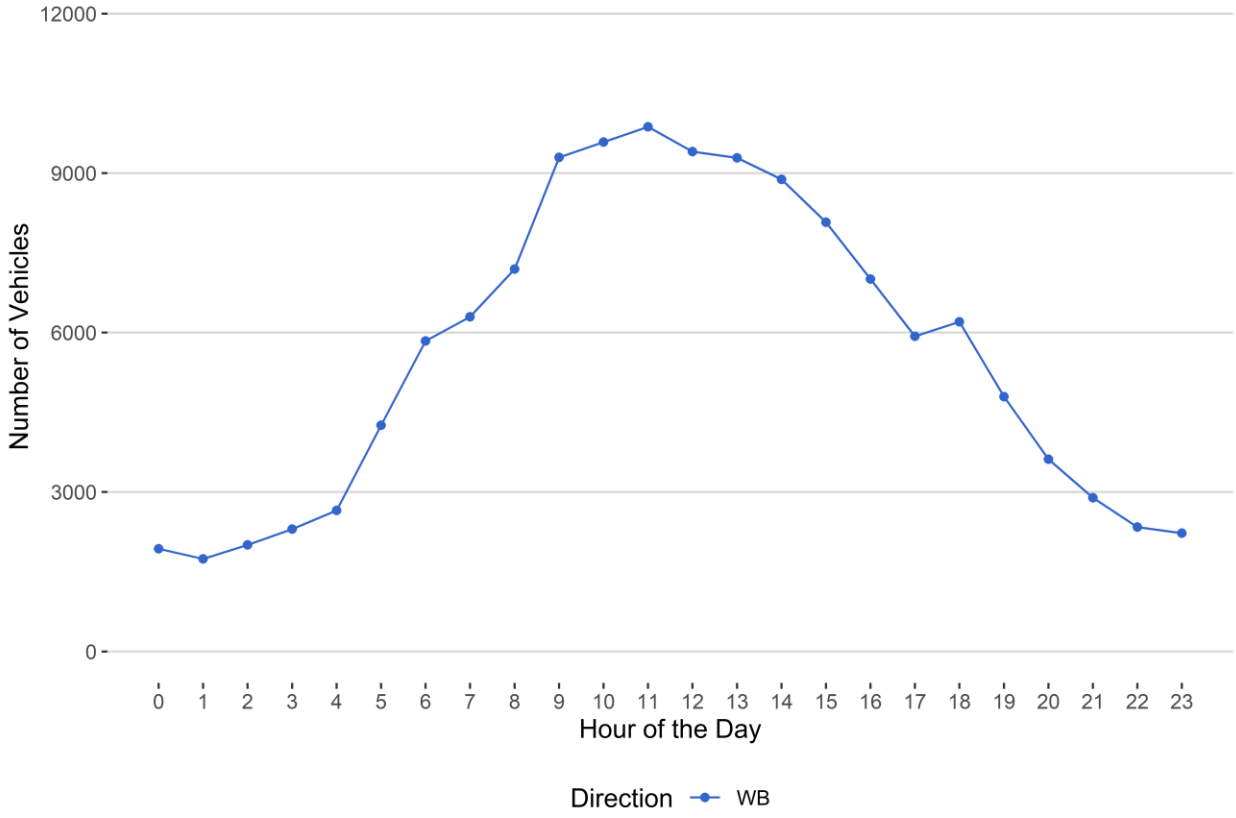


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

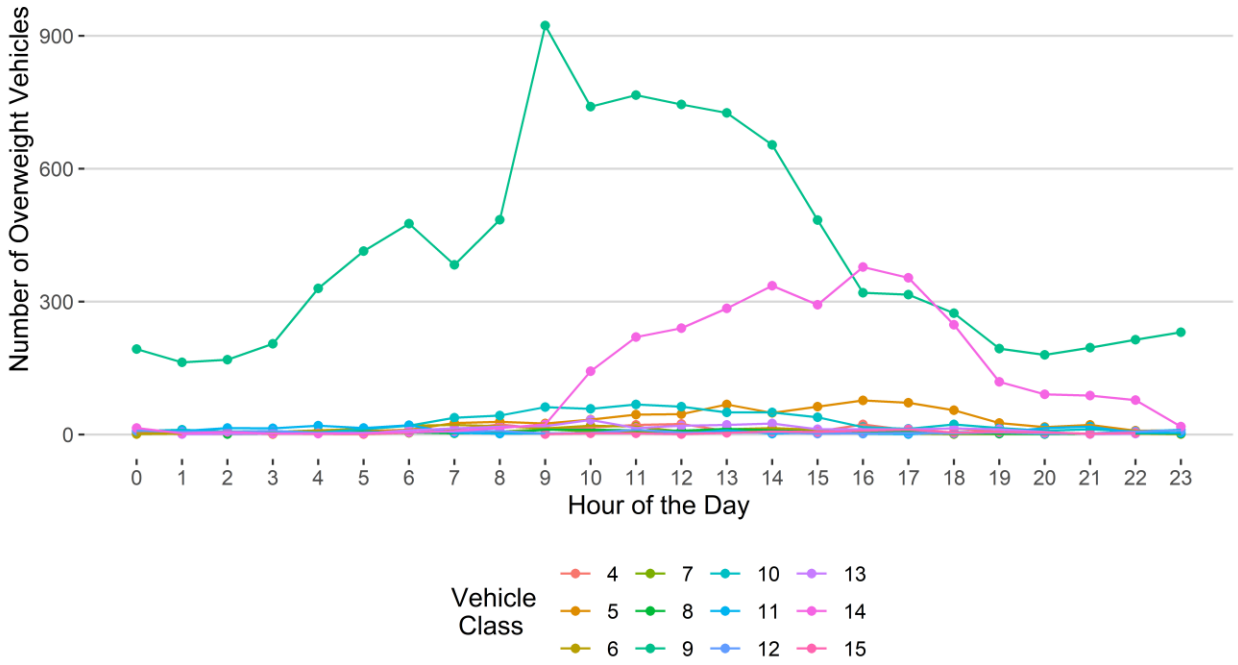


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

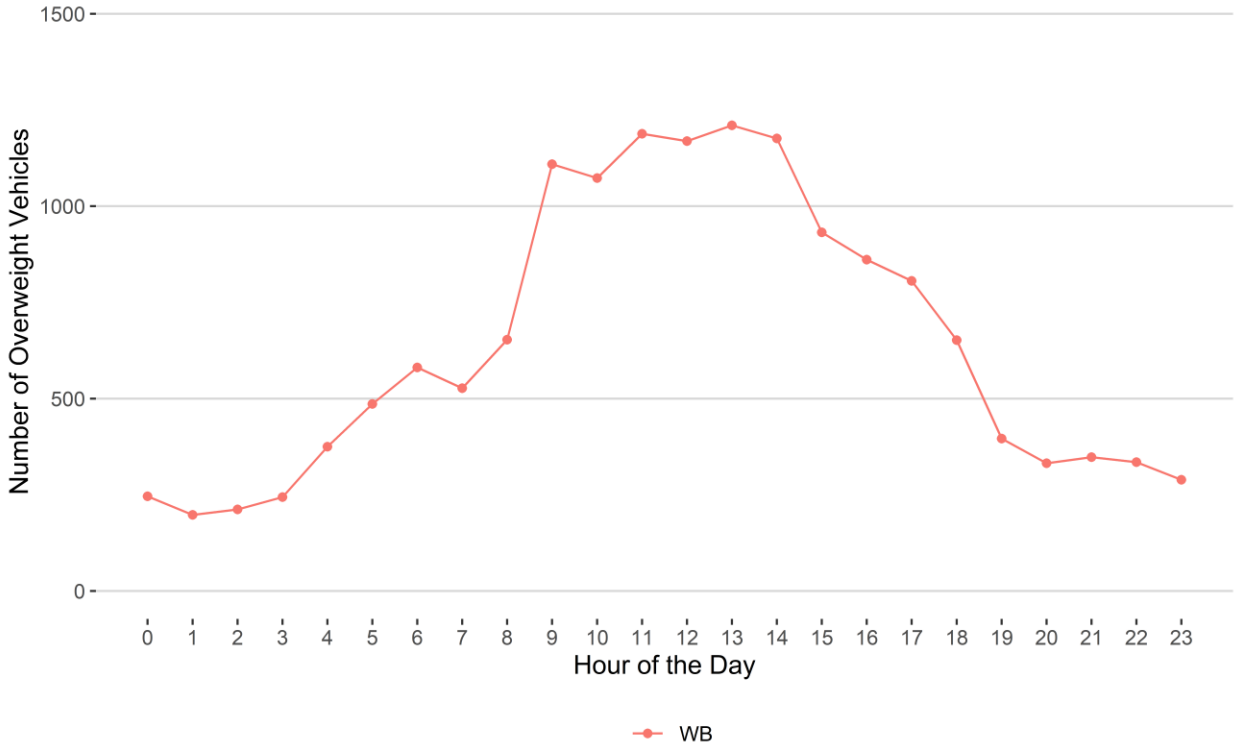
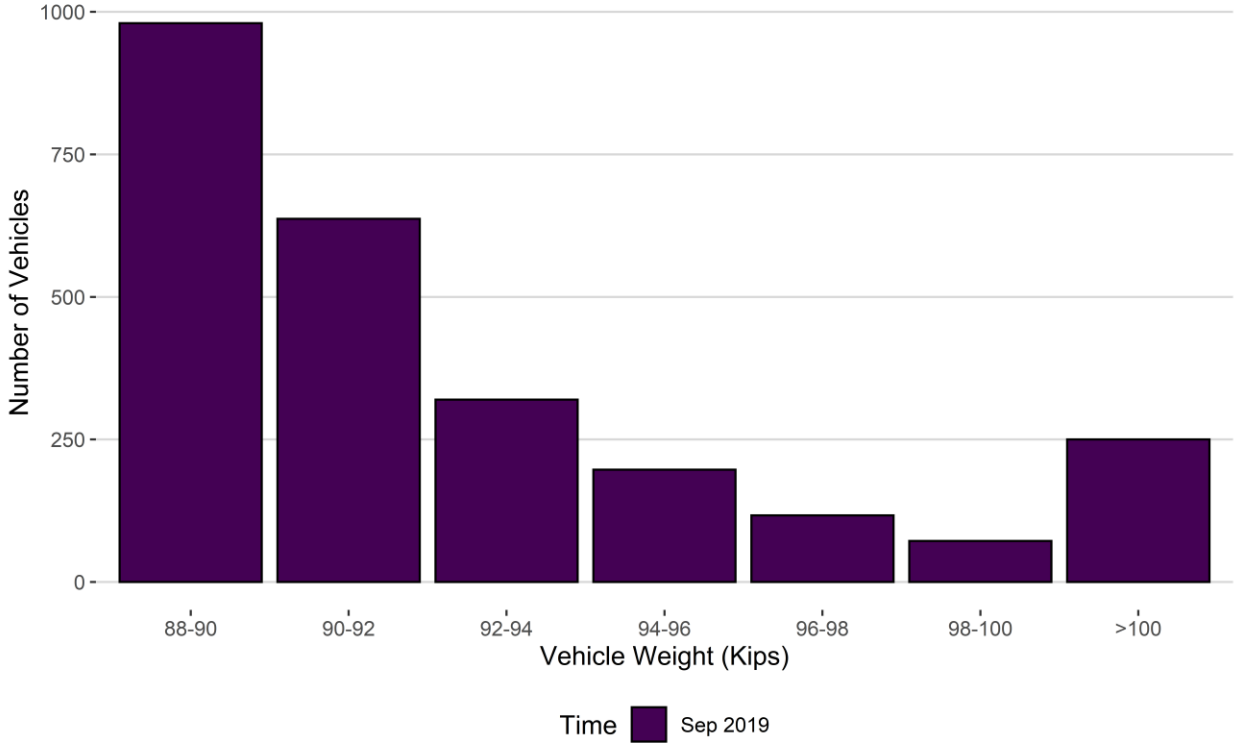


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Sep 2019*
88-90	980
90-92	637
92-94	320
94-96	197
96-98	117
98-100	72
>100	250
Total	2573

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

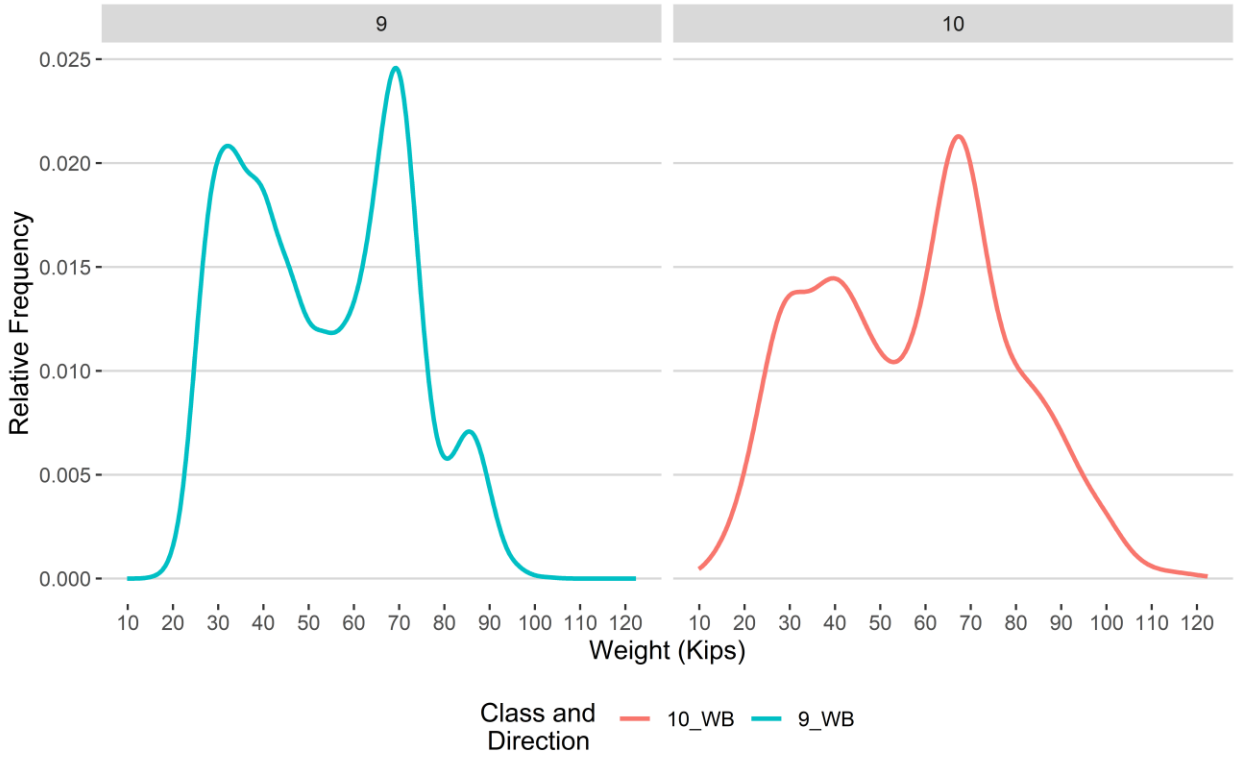


Figure 9 - Freight Percentage by Direction and Class

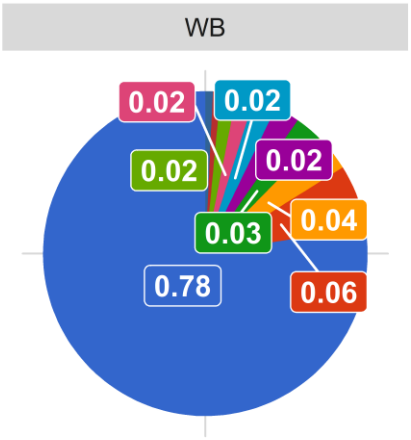


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

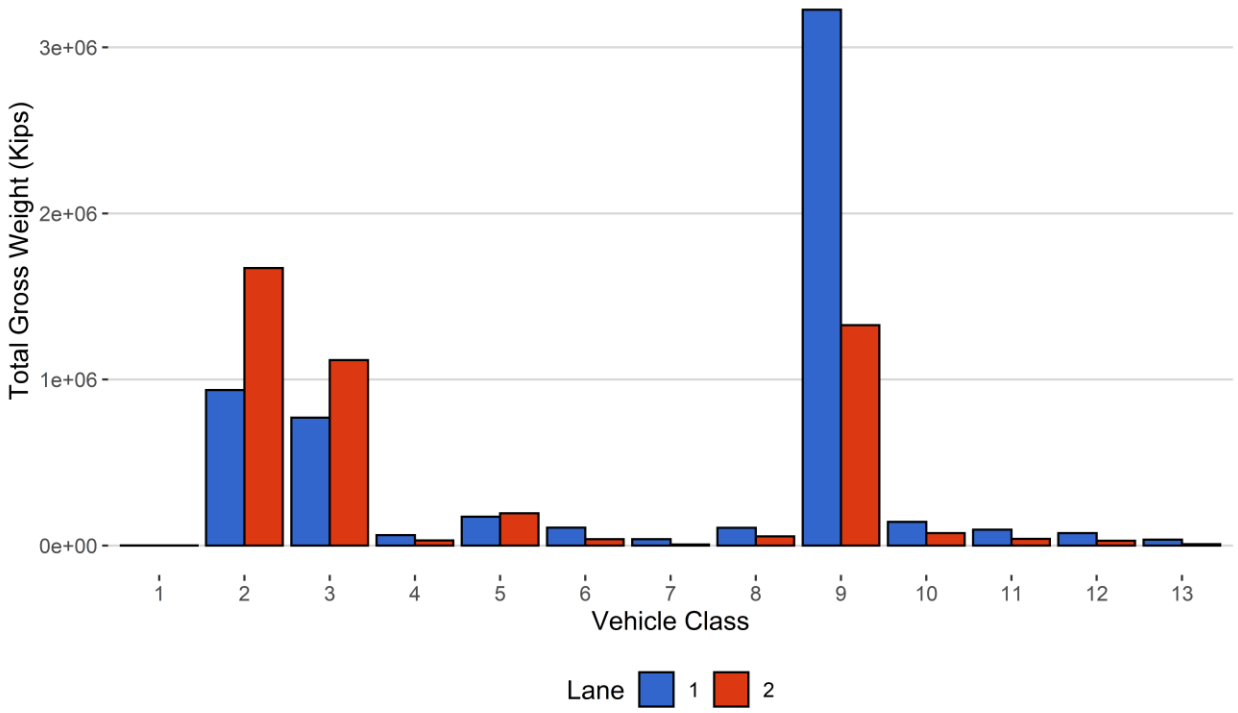


Figure 11 - Total Gross Vehicle Weight

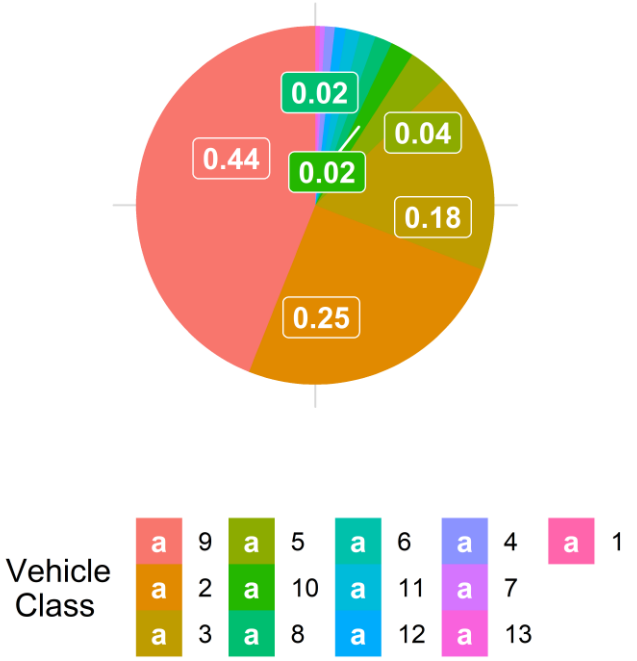


Figure 12 - Total ESALs by Class and Lane

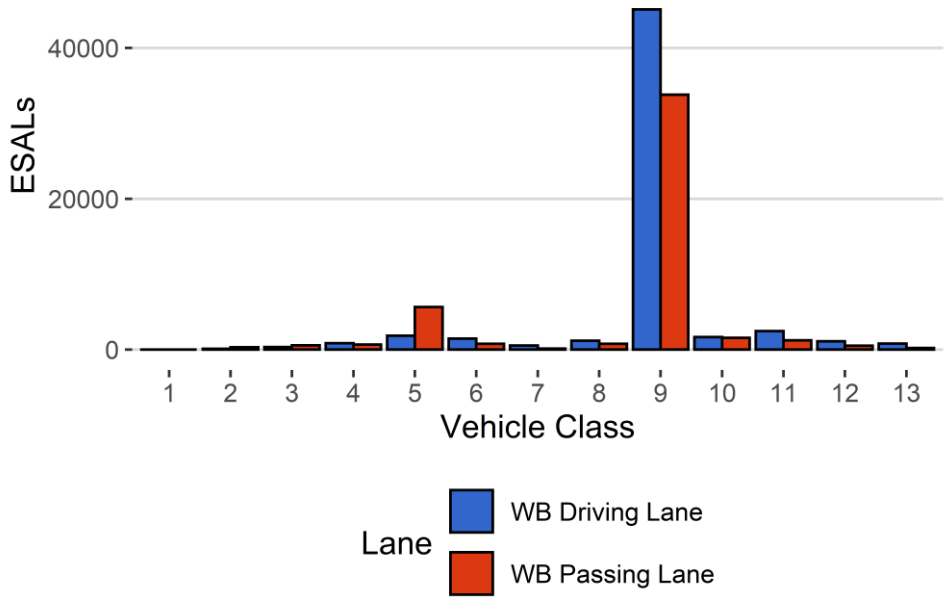


Figure 13 - ESALs by Class

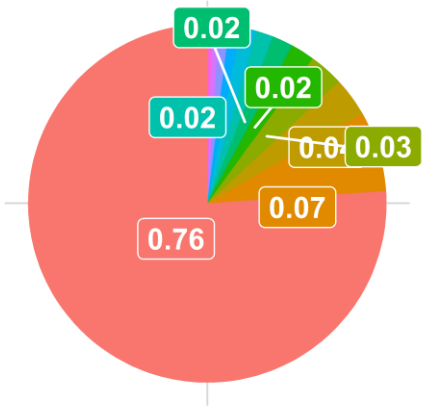


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
April 2017	10.54	0.00	11.79	0.00
May 2017	10.50	-0.39	12.19	3.41
June 2017	10.48	-0.62	11.90	0.95
July 2017	10.45	-0.84	11.92	1.16
August 2017	10.45	-0.89	12.01	1.90
September 2017	10.52	-0.26	11.86	0.67
October 2017	10.53	-0.12	12.02	1.94
November 2017	10.54	0.00	12.84	8.98
December 2017	10.55	0.02	12.67	7.46
January 2018	10.54	-0.06	12.69	7.65
February 2018	10.55	0.02	12.70	7.79
March 2018	10.55	0.02	12.51	6.17
April 2018	10.45	-0.90	12.28	4.18
May 2018	10.44	-0.99	11.98	1.65
June 2018	10.48	-0.64	11.92	1.16
July 2018	10.49	-0.48	12.02	2.01
August 2018	10.54	-0.07	12.03	2.06
September 2018	10.52	-0.18	12.23	3.79
September 2019	10.49	-0.51	12.30	4.33

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
1	3	92	0	0	0
2	19864	595934	59.1	0	0
3	9167	274996	27.3	0	0
4	121	3615	0.4	218	1.8
5	879	26357	2.6	715	5.8
6	164	4930	0.5	207	1.7
7	32	960	0.1	87	0.7
8	181	5416	0.5	125	1
9	2934	88005	8.7	9781	79.1
10	129	3881	0.4	649	5.3
11	74	2233	0.2	191	1.5
12	56	1670	0.2	129	1
13	17	503	0	256	2.1
TOTAL	**33620**	**1008591**	**100**	**12358**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-09-18	Wednesday	03:50:04	10	WB	2	122.34
2019-09-27	Friday	03:10:29	10	WB	1	119.72
2019-09-13	Friday	13:41:30	10	WB	2	119.5
2019-09-21	Saturday	05:16:37	10	WB	2	118.97
2019-09-21	Saturday	06:56:32	10	WB	2	118.88
2019-09-05	Thursday	09:58:56	10	WB	2	118.55
2019-09-27	Friday	12:17:06	10	WB	1	115.91
2019-09-29	Sunday	17:37:28	10	WB	2	115.6
2019-09-25	Wednesday	18:49:49	10	WB	1	115.47
2019-09-10	Tuesday	12:03:25	10	WB	2	114.77

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	WB	15	3512	460	13.1	86942	6137	20581
5	WB	8	25605	1144	4.5	359032	8246	81672
6	WB	19	4789	267	5.6	141171	4575	27627
7	WB	11.5	933	0	0	44352	0	16811
8	WB	31	5261	2701	51.3	99372	61555	10006
9	WB	33	85494	15009	17.6	4127282	426299	900639
10	WB	33.5	3770	654	17.3	198919	17456	47267
11	WB	36.5	2169	63	2.9	134054	1660	28593
12	WB	36.5	1622	28	1.7	102352	760	22085
13	WB	31.5	489	0	0	43676	0	14136
TOTAL	****	****	**133644**	**20326**	****	**5337154**	****	**1169417**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*WB Driving Lane*	*WB Passing Lane*	*Total*	*Percentage*
1	73	39	112	0
2	936329	1671004	2607332	25.2
3	769936	1116344	1886280	18.2
4	62073	31006	93079	0.9
5	173553	193726	367278	3.5
6	107630	38117	145747	1.4
7	38313	6039	44352	0.4
8	106363	54564	160927	1.6
9	3226499	1327082	4553581	44
10	142093	74283	216376	2.1
11	95619	40096	135715	1.3
12	74829	28282	103111	1
13	35490	8187	43676	0.4
TOTAL	**5768799**	**4588768**	**10357567**	**100**
GVW/LANE	**55.7**	**44.3**	**100**	**0**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*WB Driving Lane*	*WB Passing Lane*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0.0111
2	119	315	434	0.4	0.0015
3	338	574	912	0.9	0.0068
4	859	667	1526	1.5	0.87
5	1839	5648	7487	7.2	0.59
6	1467	780	2248	2.2	0.94
7	549	128	677	0.6	1.45
8	1176	768	1943	1.9	0.74
9	45098	33807	78905	76.1	1.85
10	1673	1558	3231	3.1	1.71
11	2463	1231	3694	3.6	3.4
12	1096	518	1614	1.6	1.98
13	797	224	1021	1	4.1
TOTAL	**57475**	**46218**	**103693**	**100**	**18**
ESALS/LANE	**55.4**	**44.6**	**100**	**–**	**–**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*
Sep 2019	1008591	33620	4586	871021	86.4	137569.5	13.6
TOTAL	**1008591**	**–**	**–**	**871021**	**–**	**137570**	**–**
AVERAGE	**1008591**	**33620**	**4586**	**871021**	**86**	**137570**	**14**

###ESALs

Month	*ESALS WB Driving Lane*	*ESALS WB Passing Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Sep 2019	57713	282452	340165	34.4
TOTAL	**57713**	**–**	**–**	**–**
AVERAGE	**57713**	**282452**	**340165**	**34**

###Gross Vehicle Weight

Month	*GVW WB Driving Lane*	*GVW WB Passing Lane*	*Total GVW Kips*
Sep 2019	5780096	4752543	10532640
TOTAL	**5780096**	**4752543**	**10532640**
AVERAGE	**5780096**	**4752543**	**10532640**

###Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
Sep 2019	15331	1.6	11.1	2659	388
TOTAL	**15331**	**–**	**–**	**2659**	**388**
AVERAGE	**15331**	**1.6**	**11.1**	**2659**	**388**

###Freight

Month	*WB Freight Tons*
Sep 2019	1169417
TOTAL	**1169417**
AVERAGE	**1169416.8**